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**Unit 6 Notes, Part 3: Cell Cycle Regulation**

Mrs. Krouse, AP Biology

***Please do one page (front and back) of notes annotations on a separate sheet of paper. Pay particular attention to the two textbook pages that are attached to these notes.***

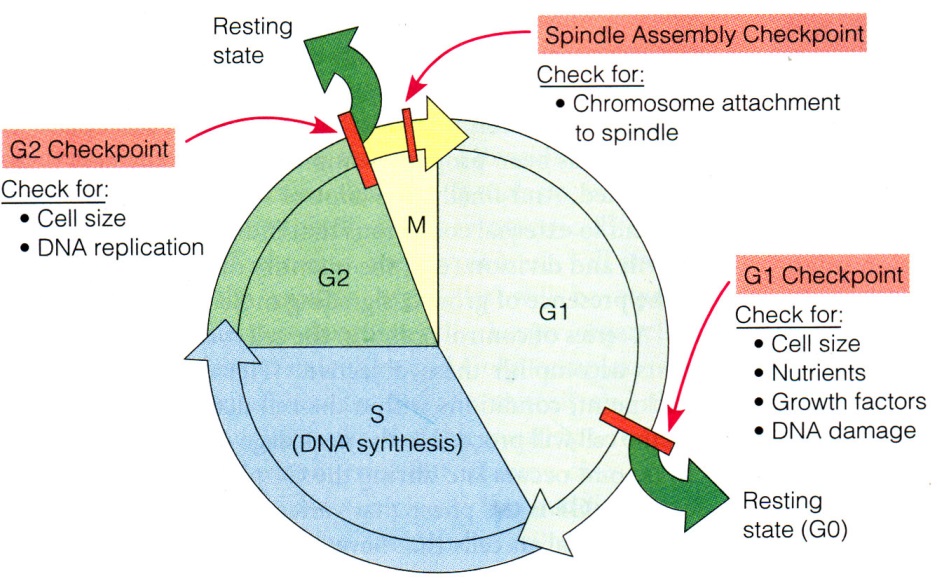
**Organization of Genetic Material**

1. The timing of the cell cycle is crucial for normal growth, development, and maintenance.
2. The frequency of cell division changes depending on the cell type

* Some divide frequently (ex: skin cells, blood cells)
* Some can be induced to divide (ex: liver cells)
* Some don’t divide after maturity (ex: nerve cells, muscle cells)

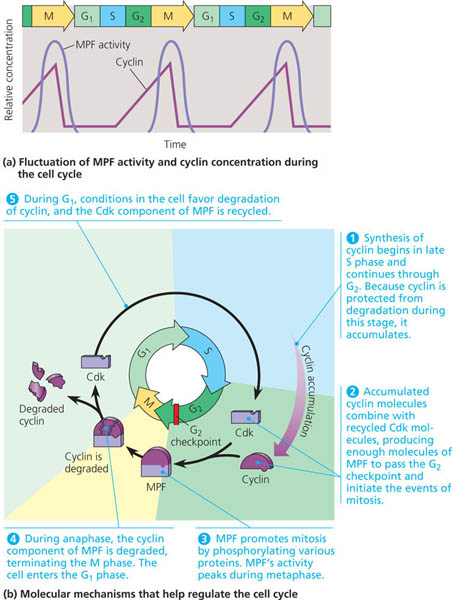
1. Chemical signals in the cytoplasm control the cell cycle
2. Critical points where signals tell the cell to continue dividing or stop are called checkpoints.
3. There are three major checkpoints: the G1 phase checkpoint, the G2 phase checkpoint, and the M phase checkpoint

**Three Different Checkpoints**

1. [](http://www.google.com/url?sa=i&rct=j&q=&esrc=s&source=images&cd=&cad=rja&docid=W6zMELM36rPPOM&tbnid=Ly3Vo_7hK4ou5M:&ved=0CAUQjRw&url=http://greatcourse.cnu.edu.cn/xbfzswx/wlkc/kcxx/11English.htm&ei=LgTPUvCMIqTisASqh4CgDA&bvm=bv.59026428,d.eW0&psig=AFQjCNEZUGrfWsicp-Dz4sg8YCt0ec9U2w&ust=1389385109362202)The G1 phase checkpoint is probably the most important.

* If a cell gets the go-ahead, it copies its DNA and divides
* If no signal is given, the cell exits the cycle and enters a non-dividing state (the G0 phase)
* Most human body cells are in G0, and some can return to the cycle with external cues (ex: growth factors released by injury can stimulate liver cells to divide again)

1. The G2 checkpoint decides whether or not cells enter the M phase
2. The M phase checkpoint makes sure that all chromosomes are attached to the spindle at metaphase before anaphase

**Signals within One Cell**

1. Kinases are protein enzymes that control the cell cycle. They are present all the time in the cell, but they are typically inactive
2. They are activated only when connected to cyclin proteins. This is why they are called cyclin-dependent kinases (Cdk’s). Specific kinases give the go-ahead signals at the G1 and G2 checkpoints.
3. As a specific example, cyclin molecules combine with Cdk molecules produce enough molecules of a cyclin-CdK complex called MPF (maturation/mitosis promoting factor) to pass the G2 checkpoint and enter the M phase (mitosis phase)
4. The mechanism of CdK regulation of the cell cycle is unknown, but it is thought to help by phosphorylating (adding a phosphate group to) other proteins, which activates them. These phosphorylated proteins may be used to assist with events that begin mitosis (ex: coiling of chromosomes and creation of the mitotic spindle).

**Signals from Other Cells**

1. A growth factor is a protein released by one group of cells that can stimulate other cells to divide
2. Example: PDGF (platelet-derived growth factors) are produced by platelet blood cells. Platelet blood cells are used to clot the blood and help form a scab. PDGF secreted by platelets stimulates fibroblasts (a type of cell found in connective tissue) to divide. Fibroblasts secrete extracellular matrix materials and collagen proteins that help “knit” the skin together to continue the healing process.

**How does a cell stop dividing?**

1. During anaphase, MPF switches itself off by starting a process that leads to the destruction of cyclin molecules.
2. Without cyclin molecules, Cdk molecules become inactive, bringing mitosis to a close

**Normal Cell Division**

1. Normal cell division has two characteristics:

* Density-Dependent Inhibition – when crowded cells stop dividing (can only form one layer)
* Anchorage Dependency – normal cells must be attached / anchored to something to divide.

**Abnormal Cell Division – Cancer**

1. Cancer cells exhibit neither density-dependent inhibition nor anchorage dependency
2. Normal cells divide 20-50 times in culture conditions, then stop, age, and die ; cancer cells are “immortal” (HeLa cells from a tumor removed from a woman – Henrietta Lacks— in 1951 are still reproducing in culture)
3. A tumor is a mass of abnormal cells within otherwise normal tissue that forms due to unregulated cell division.
4. If the abnormal cells remain at the original site, the lump is called a benign tumor. Cells from a different type of tumor—a malignant tumor—can break off and spread to other parts of the body and cause the growth of new tumors in other locations. An individual with a malignant tumor is said to have cancer.
5. Metastasis occurs when cells separate from a malignant tumor and enter blood or lymph vessels and travel to other parts of the body.
6. There are many causes of cancer but they always involve the alteration of genes that control the cell cycle
7. Cancer cells do not stop dividing when growth factors (protein or steroid hormones from other cells that signal a cell to divide) are depleted ; they also do not stop dividing at normal cell cycle checkpoints
8. Cancer cells may secrete signal molecules that cause blood vessels to grow toward the tumor. This growth of blood vessels to supply blood to the tumor and increase the risk of metastasis is called angiogenesis.

**Cancer Treatment**

1. Usually targets quickly-dividing cells
2. Treatment may involve high-energy radiation or chemotherapy (a form of cancer therapy involving drugs that interfere with specific steps in the cell cycle)
3. Example: Taxol interferes with the breakdown of microtubules from the mitotic spindle ; cells get stuck in metaphase
4. There are many side effects of chemotherapy drugs (ex: hair loss, nausea) due to the effects on normal, quickly-dividing cells (ex: hair follicle cells, stomach lining cells)

**Notes Questions**

1. Why might the G1 checkpoint be the most important in regulating the cell cycle?
2. If the cell “notices” that not all the chromosomes are attached to spindle fibers, what happens? What checkpoint does this relate to?
3. What is the only situation where mature liver cells will exit the G0 state?
4. If cyclin cannot accumulate during interphase, how will this affect the activity of cyclin-dependent kinases?
5. What types of proteins does MPF phosphorylate (i.e. activate) to initiate the beginning of mitosis?
6. If PDGF’s are not released by platelet blood cells after an injury, how will this affect healing? (Use the term fibroblasts in your answer.)
7. How does MPF end cell division?
8. Describe two ways in which cancer cell division differs from normal cell division.
9. Explain how metastasis and angiogenesis relate to one another.
10. How is a benign tumor different from a malignant tumor?
11. What types of cells are “targeted” by chemotherapy drugs? Why do people experience hair loss during chemotherapy?
12. Why is Taxol effective in slowing down cell division?